

# NOTES ON, AND DESCRIPTIONS OF NEW HEBRIDEAN LAND SNAILS

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# NOTES ON, AND DESCRIPTIONS OF NEW HEBRIDEAN LAND SNAILS

By ALAN SOLEM

## A. INTRODUCTION

CURRENT knowledge of the New Hebridean land and fresh-water Mollusca was recently summarized by Solem (1959) in a study based primarily upon material in North American museum collections and a review of the previous literature. Since completion of that study in 1957, it has been possible to borrow some very important material from the British Museum (Natural History), and to obtain field collections made by Borys Malkin in 1958. Study of these collections has been long delayed and it proved impossible to devote the necessary time to reworking the numerous series of slugs. Critical examination of the shelled forms revealed four new species, including one new genus, clarified the family position of a very unusual genus (*Draparnaudia*), and added considerably to our knowledge of distribution patterns within the New Hebrides.

The British Museum (Natural History) collections are principally those made by J. R. Baker and Tom Harrisson and party in the 1920's and 1930's primarily with the Oxford University Expedition to the New Hebrides, 1933-34, and a few sets collected by L. E. Cheesman in the mid-1930's. Of particular importance was a collection of seven shells from Tatarii village, at 4,000 feet above sea level on the slopes of Mt. Tabwemasana in Western Espiritu Santo. Six specimens represented a new species of an otherwise New Zealand genus and the seventh is a new genus of a primitive helicarionid sub-family.

Borys Malkin visited several islands (Maewo, Aoba, Malekula and Vanua Lava) where the Molluscan fauna was very poorly known. Besides collecting two previously unknown species, his efforts added significantly to our knowledge of inter-island distribution. The dates of his malacological collections are : Vate Island (21st-22nd July, 1958) ; Espiritu Santo (23rd-28th, 31st July, 18th-19th, 24th-25th, August, 27th-30th September, 1958) ; Vanua Lava, Banks Group (6th-11th August, 1958) ; Maewo 29th August to 4th September, 1958). His collections are deposited in the Chicago Natural History Museum (hereafter CNHM).

## ACKNOWLEDGMENTS

For kind permission to study the specimens in the British Museum (Natural History) collections, I am indebted to the Trustees of that institution. The drawings of *Phrixgnathus tatariiensis* were done by E. John Pffner and those of *Pseudosesara tabwemasanana* by Marion Pahl, Staff Artists at Chicago Natural History Museum ; drawings of the other shells are by Marcia Oddi, Temporary Assistant, Department of Zoology, Chicago Natural History Museum. The anatomical drawings were prepared by Miss Oddi from dissections made by the author. Drs. Yoshio Kondo and H. B. Baker have given advice concerning the systematic position of *Draparnaudia*.

## B. NOTES AND DESCRIPTIONS OF SPECIES

Class *GASTROPODA*Subclass *PULMONATA*Superorder *STYLOMMATOPHORA*Order *HETERURETHRA*Superfamily *SUCCINEACEA*Family *SUCCINEIDAE*Genus *SUCCINEA* Draparnaud, 1801*Succinea (Papusuccinea) kuntziana* Solem, 1959*Succinea (Papusuccinea) kuntziana* Solem, 1959 : 55-58, pl. 5, figs. 1, 3-8, pl. 13, fig. 3.

Borys Malkin collected one adult under a rotting log near Luganville, Espiritu Santo (CNHM 109414). J. R. Baker and party found two adults in or near Steaming Hill Lake, Gaua, Banks Group. Apparently this species is widely distributed in the New Hebrides.

Order *ORTHURETHRA*Superfamily *VERTIGINACEA*Family *PUPILLIDAE*Genus *GASTROCOPTA* Wollaston, 1878*Gastrocopta (Sinalbinula) pediculus* (Shuttleworth, 1852)*Gastrocopta (Sinalbinula) pediculus* (Shuttleworth) : Solem, 1959 : 58-59.

Six adults from Norovorovo, Maewo (CNHM 109351) collected by Borys Malkin add the second known New Hebridean record for this snail that has been widely dispersed by commerce.

Family *ENIDAE*Genus *RHACHISTIA* Connolly, 1925*Rhachistia histrio* (Pfeiffer, 1854)*Rhachistia histrio* (Pfeiffer) : Solem, 1959 : 60-62, pl. 8, fig. 9, pl. 13, fig. 5.

Specimens in the British Museum (Natural History) collection from Vate confirm the many prior records from this island. A large series of this species was obtained by Borys Malkin on Mare, Loyalty Islands, New Caledonia (CNHM 109435, 109436). A set of these was forwarded to Dr. B. Verdcourt, East African Herbarium, Nairobi, Kenya, for comparison with African species. He has reported elsewhere (Verdcourt, 1961) that the New Hebridean-New Caledonian form is the same as the East African *Rhachidina braunsii* (von Martens), thus tending to confirm my suggestion of 1959 that *histrio* has been introduced into the Pacific Islands and Australia. Because the generic position of these shells is uncertain, I have retained the name used in my previous paper.



## Subfamily DRAPARNAUDIINAE, new subfamily

Orthurethrous holopods, foot with median groove, spermatheca enlarged in basal portion, penis unforked with subapical epiphallic insertion through a large stimulatory pad. No appendages on spermatheca or penis. Radula enid with central reduced in size, bicuspid laterals and multicuspid marginals. Jaw crescent shaped with very weak striations.

It is quite difficult to know where to classify this group, since the anatomy of the Orthurethra is known to show many parallelisms and convergences. Combinations of the varying characters outlined above exclude *Draparnaudia* from most family units and certain features show strong similarities to various families. The swollen spermatheca with apical sac imbedded in the prostate is present in the European Chondrinidae, although to a lesser extent, but the radula of *Draparnaudia* is enid in character, agreeing well with those of west chinese species figured by Wiegmann (1901) Where *Draparnaudia* differs most strikingly is in the simplified penis, which is totally without any appendages or a split retractor muscle. The internal papilla of the penis is quite similar to that known for certain enids, however, and secondary reduction of the penial complexities is a common phenomenon in the Orthurethra. Few Asian or Indonesian enids have been dissected, so that forms transitional from typical enids to the simplified condition of *Draparnaudia* may well be discovered.

The amastrid-cochlicopid lines have penial appendages and the genital orifice well removed from the tentacle and near the mantle. The partulids have a shortened, triangular kidney approaching that of the Mesurethra, while the tornatellinids have the modified radula and greatly shortened uterus and prostate complex. *Draparnaudia* is thus effectively excluded by the above characters from any of the endemic Pacific Ocean orthurethran families. The usually toothed pupillids differ in the penial complexities, shortened spermatheca, uterus and prostate, and differently formed radular teeth.

The female genitalia of *Draparnaudia* is close to that of the Orculidae and Chondrinidae (see Steenberg, 1925 : pls. 2-8, particularly pl. 5), but the toothed, pupiform shell, penial complexities and varying radular structures of these groups do not indicate a close relationship. Association of *Draparnaudia* with the Enidae is based on the radula, the toothless, relatively smooth shell, and the similarity of the apical genitalia to that of the enid *Pseudochondrula*. The enlargement of the spermatheca and the simplified penis are totally unlike any enid on which data has been published, thus indicating the need for subfamily recognition of this genus.

Solem (1959 : 121) discussed previous speculations on the systematic position of *Draparnaudia* (Bulimulidae, Camaenidae) and added a third suggestion (Tornatellinidae). The present dissection of *D. lifuana* does place the genus as an orthurethran, but the family position must still be considered uncertain. Until such forms as the Timor "*Pseudonapaeus*" *apertus* (Martens), New Guinea *Apoëcus colonus* (Moellendorff) and Australian-New Guinea *Amimopina macleayi* (Brazier) are dissected, it will remain uncertain as to whether *Draparnaudia* is an isolated genus or connected to the more typical Asiatic forms by the anatomies of the above mentioned enids.

Genus *DRAPARNAUDIA* Montrouzier, 1859*Draparnaudia walkeri* Sykes, 1903

*Draparnaudia walkeri* Sykes : Solem, 1959 ; 123, pl. 8, fig. 8.

Borys Malkin collected a single adult shell at Nasuli, Baldwin Bay, Espiritu Santo (CNHM 109410).

*Draparnaudia lifuana* Pilsbry, 1901

Text-figs. 1-7

*Draparnaudia lifuana* Pilsbry : Solem, 1961 : 484.

Two adult, well-relaxed specimens collected by Borys Malkin at Tadine, Mare, Loyalty Islands, New Caledonia (CNHM 109411) provide the data presented above on the systematic position of *Draparnaudia*. In an attempt to pull one specimen from the shell the animal broke in two with one part remaining inside. The other shell was destroyed in order to have an entire animal for dissection. Nervous and muscular systems were not studied because of the lack of sufficient material.

Animal (Text-fig. 1) with a light buff-coloured, holopod foot. Tail rounded above, sole with a median groove, rounded posteriorly. Gonopore (YO) below and behind left ommatophoral tentacle, nearer to tentacle than to mantle collar. Pallial region (Text-fig. 2) with orthurethrous kidney (excretory pore—KO), simple and unbranched but recurved pulmonary vein. Mantle collar with simple pneumostome, no prominent lappets. Intestine opening through fold in mantle collar. Lung without secondary veining or white flecking. Apical whorls with a network of chalky white. Genitalia (Text-fig. 3) quite distinctive. Ototestis (G) multilobate with five clumps of clavate alveoli imbedded in apical lobe of digestive gland. Hermaphroditic duct (GD) long, highly convoluted near carrefour region. Talon reduced to a short unconvoluted basal portion of hermaphroditic duct (not shown in figure) that is buried in the small albumen gland (GG). No separate carrefour region obvious, but condition of the material did not permit critical study of this region. Uterus (UT) a very thin-walled sac, swollen, without transverse folds. Free oviduct (UV) moderately long, a thin tube only moderately larger than the vas deferens (D), internally sculptured with three longitudinal rugose pilasters and a series of irregular, microscopic pilasters between the major ones. Spermatheca long, with apical sac loosely bound to prostate near to, but not reaching, the carrefour-albumen gland area. Medial portion of stalk (SS) slender, gradually becoming globosely swollen with thick muscular walls and sculptured internally (Text-fig. 4) with grooved longitudinal pilasters. Free oviduct entering laterally with a minor cluster of small pilasters radiating from the opening. Vagina (V) and spermatheca not internally differentiated, the vaginal region gradually narrowing with reduced pilaster size before junction of vagina and penial cavity to form the very short atrium (Y). Prostate (DG) a small tube bound to the uterine wall with quite numerous digitiform follicles attached to it. These tubules quite long and free of each other, variously coiled and folded. Prostate slightly shorter than uterus. Vas deferens slender, coiled around free oviduct and loosely connected by tissue to spermathecal stalk and vagina, tightly bound to atrial region. At a trial

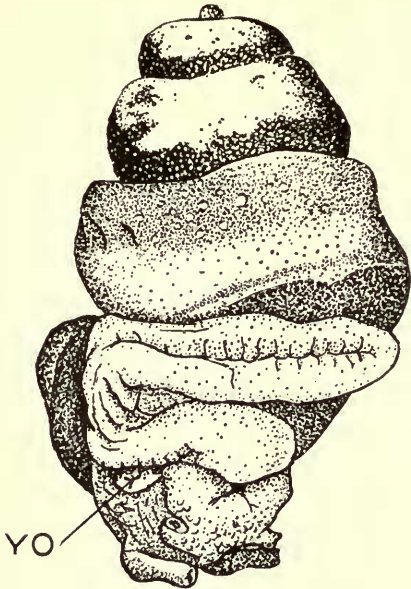


FIG. 1. *Draparnaudia lifuana* Pilsbry. Entire animal removed from shell.  
YO—gonopore

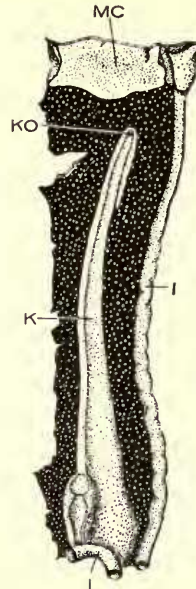


FIG. 2. *Draparnaudia lifuana* Pilsbry. Pallial region.

I—intestine  
K—kidney

KO—renal orifice  
MC—mantle collar

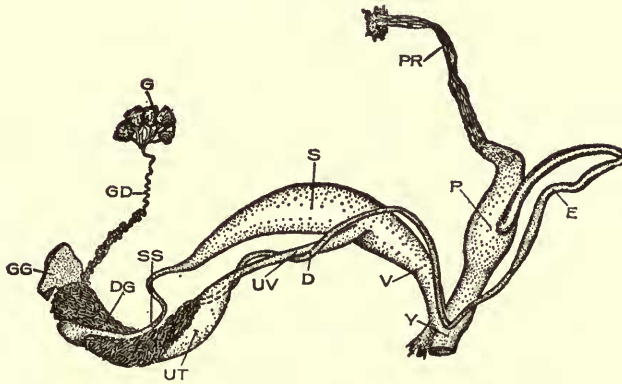


FIG. 3. *Draparnaudia lifuana* Pilsbry. Genitalia.

D—vas deferens  
DG—prostate  
E—epiphallus  
G—ovotestis  
GD—hermaphroditic duct  
GG—albumen gland  
P—penis

PR—penial retractor  
S—spermatheca  
SS—spermathecal stalk  
V—vagina  
UT—uterus  
UV—free oviduct  
Y—atrium

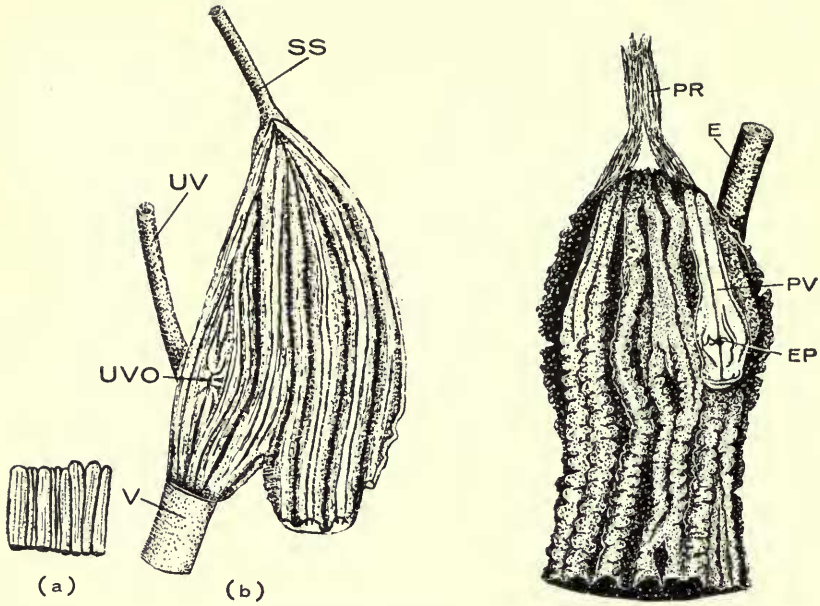


FIG. 4. *Draparnaudia lifuana* Pilsbry. Interior of spermatheca.  
 a. internal sculpture of vagina UVO—opening into vagina of free oviduct  
 b. vaginal region and lower spermathecal stalk

FIG. 5. *Draparnaudia lifuana* Pilsbry. Interior of penis.  
 PV—penial papilla proper  
 EP—pore of epiphallus

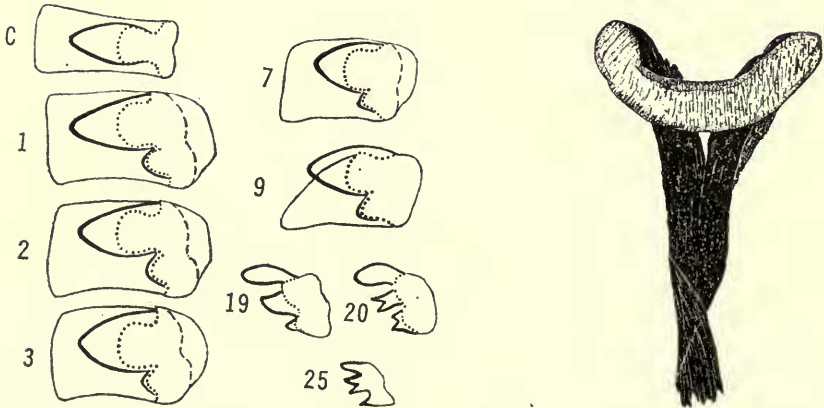


FIG. 6. *Draparnaudia lifuana* Pilsbry. Radula.  
 FIG. 7. *Draparnaudia lifuana* Pilsbry. Jaw.



region, one specimen had an enlarged, glandular sac, the other only a slight swelling (specimen drawn), probably indicating the break between the vas deferens proper and the epiphallus. The epiphallus ascends the penis, becoming a thick tube with muscular walls that loops around the penis and penial retractor. Epiphallus inserts subapically on the penis. Penis (*P*) with terminal retractor muscle (*PR*) that arises on the diaphragm. Penis sculptured internally (Text-fig. 5) with a series of longitudinal accessory pilasters that are simple above the point of entry of the epiphallus and corrugated below. Epiphallus enters penis through a high, grooved stimulatory pad that probably functions as a verge. Atrial region with small, smooth pilasters. Left ommatophoral retractor passing through penioviducal angle. Radula (Text-fig. 6) with 104 straight rows of teeth. Each row with unicuspid central that is distinctly smaller than the adjacent lateral, 9 to 10 bicuspid laterals with moderately squarish basal plates, and 16-17 marginals that are multicuspid because of split ectocones. Jaw (Text-fig. 7) very thin, crescent-shaped, aulacognath with very fine vertical striations.

Family PARTULIDAE

Genus *PARTULA* Ferussac, 1821

*Partula pyramis* Hartman, 1886

*Partula pyramis* Hartman: Solem, 1959: 69, pl. 14, fig. 9.

A single dead specimen (CNHM 109349) was collected at 1,000 feet elevation on the trail from Karo to Amok, Malekula and a number of worn shells (CNHM 109350) on the trail from Amok-Tenmaru, Malekula by Borys Malkin. Periostracum was eroded and no sculpture or colour remained. The shells have rounded whorls of the *pyramis* type and are tentatively referred to this species.

*Partula auraniana* Hartman, 1888

*Partula auraniana* Hartman: Solem, 1959: 70-71, pl. 15, figs. 1, 2, 6.

Borys Malkin collected shells from Vureas (CNHM 109347, juvenile), trail from Sola to Mosina (CNHM 109348, one adult, one juvenile) and at Mosina Bay (CNHM 109346, good set) on Vanua Lava, Banks Group. The large series from Mosina Bay was measured and the results of statistical treatment are summarized in Table 1. The range of variation includes part of the type set of *P. auraniana* from Aore Island (see Solem, 1959), but subspecific variation might be warranted when adequate samples from Aore are analysed.

Order SIGMURETHRA

Suborder AULACOPODA

Superfamily ARIONACEA

Family ENDODONTIDAE

Subfamily PUNCTINAE

Genus *PHRIXGNATHUS* Hutton, 1883

Referring two species from the New Hebrides to this New Zealand genus is supported by the discovery of a third species, described below, which has shell characters

of another group of New Zealand *Phrixgnathus* and anatomy of the punctid type. Although *P. glissoni* and *P. tenuiscriptus* have the shell characters of the New Zealand group of *P. sciadium*, the new species, *P. tatariensis*, has the shape and sculpture of the group of *P. ariel*. The microsculpture of the New Zealand and New Hebridean shells is the same, and quite different from that of the endodontinine genera of the Pacific. The anatomy of *P. tatariensis* is punctid, thus connecting the species to the New Zealand *Phrixgnathus* and *Laoma* in animal features. Since the conchology of the New Hebridean and New Zealand shells is so similar, no hesitation is felt in leaving them in the same genus. Adequate dissections of both New Zealand and New Hebridean species might, however, result in subgeneric or generic separation.

***Phrixgnathus glissoni* (Ancey, 1889)**

*Phrixgnathus glissoni* (Ancey): Solem, 1959: 81, pl. 28, figs. 3-5.

Borys Malkin found two juveniles near Luganville, Espiritu Santo (CNHM 109355) and three near adults at 1,000 feet elevation on the trail from Amok to Tenmaru, Malekula (CNHM 109354). The latter were the more trochoidal, less acutely carinated shells that Ancey called variety "B". Local forms of *P. glissoni* may be eventually recognized, but no set larger than three shells has been examined to date, so that data are totally inadequate for any consideration of subspeciation.

***Phrixgnathus tatariensis*, new species**

Text-figs. 8-10, Pl. 1, figs. 1-3

*Diagnosis.* A small species of *Phrixgnathus* with moderately elevated spire, angulated periphery, relatively narrow umbilicus, colour markings reduced to vague radial streaks and a microsculpture of fine spiral lines crossing very low and irregular growth striae. Other New Hebridean species differ in their larger size, stronger radial ribbing, colour pattern and umbilical size. New Zealand species all present differing combinations of characters.

*Holotype.* British Museum (Natural History) No. 1961653. from Tatarii Village, 4,000 feet elevation, Western Espiritu Santo, New Hebrides. Collected by John R. Baker and party in October and November 1933.

*Description.* Shell small, globosely turbinate with  $4\frac{1}{4}$  whorls. Spire moderately elevated, not swollen, sutures lightly indented and whorls only slightly rounded. Body whorl with angulated to keeled periphery located well above mid-point. Surface of shell with a distinct sheen and microsculpture of very fine incised spiral lines crossing very low and irregular growth striae. Colour corneous with vague, irregular radial reddish yellow streaks. Umbilicus open, narrow, contained 11-13 times in the diameter with slight constriction due to expansion of the basal lip. Aperture without teeth and lip simple. Diameter of holotype 3.5 mm., height 2.38 mm.

Animal with aulacopod foot, bilobed sigmurethrous kidney, typically punctid teeth and jaw. Male genitalia with apical insertion of penial retractor, subapical entrance of epiphallus (?) and heavily pilastered penis. Other aspects of anatomy not studied.

*Paratypes.* British Museum (Natural History) No. 1961654 and Chicago Natural History Museum No. 110859 from the type set.

*Discussion.* The animals had retracted into the shell before death and the shell had been almost completely decalcified in the preservative. It was thus necessary to destroy the shell during dissection of the soft parts and great care had to be exercised in the handling of the very fragile specimens. The degree of retraction and condition of the soft parts rendered dissection quite difficult and only features of the gross morphology could be observed. Other than jaw and dentition, no other aspect of laomid anatomy has been recorded and the meagre results obtained here provide very important data about their classification. The pallial region is of the same type found in the Holarctic *Punctum* (Pilsbry, 1948, p. 642, fig. 349e), possessing the quite peculiar bilobed sigmurethrous kidney (Text-fig. 8). The radular teeth are typically

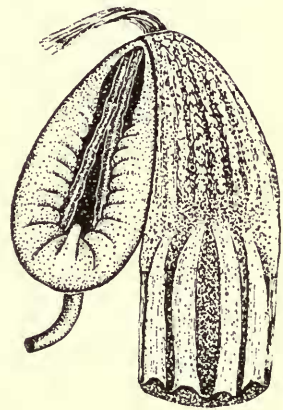
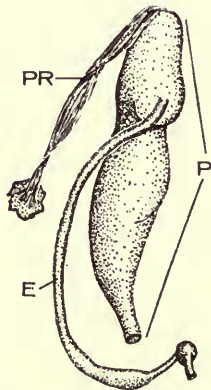
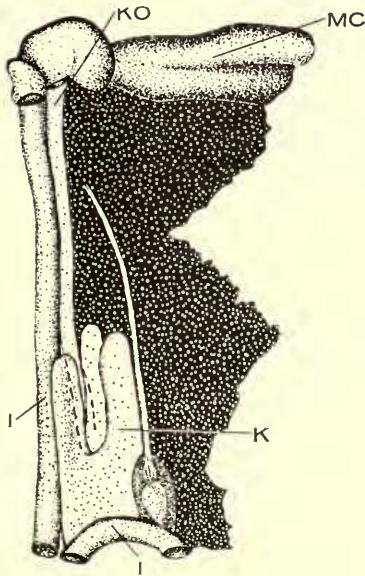


FIG. 8. *Phrixgnathus tatarimensis*. Pallial region.

FIG. 9. *Phrixgnathus tatarimensis*. Male genitalia.

FIG. 10. *Phrixgnathus tatarimensis*. Interior of penis

punctid. The jaw is composed of numerous rhombic plates that are very loosely connected by a thin membrane. The male genitalia (Text-figs. 9, 10) have a complex internal pilaster system, probably associated with spermatophore formation. In one of the two animals dissected, a large, muscular spermatophore was present in the lower part of the penis. The subapical insertion of the epiphallus clearly separates *Phrixgnathus* from *Punctum*, although other anatomical features are similar.

The shell of *P. tatarimensis* (Pl. 1, figs. 1-3) is perhaps most similar in shape to the New Zealand *P. subariel*, obviously differing in umbilicus, sculpture, colour pattern and degree of keeling. The colour pattern is more reduced than in any *Phrixgnathus*, approaching some of the *Paralaoma* in tonal quality. Sculpture was about as in *P. celia*.



## Subfamily ENDODONTINAE

Genus **MOCELLA** Iredale, 1915***Mocella euryomphala*** Solem, 1959*Mocella euryomphala* Solem, 1959 : 83-85, pl. 6, figs. 7-8, pl. 31, figs. 1-5.

Specimens collected at Norovorovo, Maewo (CNHM 109384) by Borys Malkin and on Gaua, Banks Group by J. R. Baker in 1928 show no important differences from paratypes of this Espiritu Santo species and indicate that it is widely distributed in the New Hebrides.

## Superfamily LIMACACEA

## Family HELICARIONIDAE

## Subfamily EUCONULINAE

Genus **CONEUPLECTA** Moellendorff, 1893***Coneuplecta (Sitalina) microconus*** (Mousson, 1865)*Coneuplecta (Sitalina) microconus* (Mousson) : Solem, 1959 : 94-95, pl. 34, fig. 10.

Borys Malkin found specimens at Bankaharijitoa, 1,500-2,000 feet elevation, above Dunduy, Aoba (CNHM 109377) and J. R. Baker collected it on Gaua and Espiritu Santo. A common species widely dispersed by human agency.

## Subfamily MICROCYSTINAE

Genus **LIARDETIA** Gude, 1913***Liardetia (Liardetia) samoensis*** (Mousson, 1865)*Liardetia (Liardetia) samoensis* (Mousson) : Solem, 1959 : 96-97, figs. 3, *d-f*, pl. 33, figs. 4-6.

New island records are provided by shells from 500 feet elevation above Nasaua, Maewo (CNHM 109383) and on the trail from Sola to Mosina, Vanua Lava, Banks Group (CNHM 109376). This is another species spread by commerce.

## Subfamily SESARINAE

This primitive helicarioid subfamily was previously represented in the New Hebrides by two genera, *Orpiella* and *Dendrotrochus*. A single shell collected by J. R. Baker in 1934 at Tatarii Village, 4,000 feet elevation on the slopes of Mt. Tabwemasana, Espiritu Santo (see Baker, 1935 for a description of the area) proved to be a new species and genus, related anatomically to *Dendrotrochus*, but having quite primitive shell characters. It is described below as *Pseudosesara tabwemasana*.

Genus **ORPIELLA** Gray, 1855***Orpiella (Halozonites) retardata depressa*** Solem, 1959*Orpiella (Halozonites) retardata depressa* Solem, 1959 : 100-101, pl. 34, figs. 4-6.

Borys Malkin collected shells from near Luganville, Espiritu Santo (CNHM 109381) and nearly adult shells from the trail between Karo and Amok, Malekula (CNHM 109382).

Genus *DENDROTRUCHUS* Pilsbry, 1894*Dendrotrochus (Santotrochus) eva eva* (Pfeiffer, 1853)

*Dendrotrochus (Santotrochus) eva eva* (Pfeiffer): Solem, 1959: 102-103, pl. 10, fig. 13, pl. 25, figs. 1, 2.

There is considerable variation in size, shape, colour pattern and degree of carination. Material collected by Malkin & Baker extend both the geographical range and the known range of shell variation. A set of sixteen shells from "Vate Island" collected by Baker in 1926 had eleven unbanded, four with wide spiral bands and one with a narrow spiral band. The six adults were 9.1-11.0 mm. high, 12.2-15.2 mm. in diameter, h/d ratio 0.70-0.75, with  $5\frac{1}{3}$ - $5\frac{5}{8}$  whorls. A single individual from the waterfall on the Boofa R., Vate collected by J. R. Baker in 1922 was 11.8 mm. high, diameter 13.9 mm., h/d ratio 0.85, with  $6\frac{1}{4}$  whorls. The whorl count and h/d ratio of this specimen are the greatest yet known for *D. eva eva*, and approach the measurements of *D. layardi*.

Borys Malkin collected juveniles at 1,000 feet elevation on the trail from Karo-Amok, Malekula (CNHM 109357) and at 1,500-2,000 feet elevation at Bankaharijittoa above Dunduy, Aoba (CNHM 109358). Both juveniles (CNHM 109359) and an adult (CNHM 109360) were taken at 500-800 feet elevation near Nasaua, Maewo, and one dark brown adult with a sharp keel was collected at Norovorovo school above the village, Maewo (CNHM 109361). Previously, this race was known only from Epi and Vate Islands.

*Dendrotrochus (Santotrochus) eva stramineus* Sykes, 1903

*Dendrotrochus (Santotrochus) eva stramineus* Sykes: Solem, 1959: 103-104, pl. 10, fig. 14, pl. 25, figs. 3-5.

Borys Malkin found a single sub-adult shell at Vureas, Vanua Lava, Banks Group (CNHM 109362). Like other reported Banks' shells, it was without any colour band and relatively small in size. Possibly the Banks' populations are subspecifically separable.

*Dendrotrochus (Santotrochus) layardi* (Hartman, 1889)

*Dendrotrochus (Santotrochus) layardi* (Hartman): Solem, 1959: 105-106, pl. 6, figs. 5, 6, pl. 7, figs. 3, 4, pl. 25, figs. 6-9.

In 1929 J. R. Baker collected specimens from Toneva and East Central Espiritu Santo. The latter were quite depressed for this species, but had the typical colour patterns. Borys Malkin found a few examples near Luganville (CNHM 109363), and at Baldwin Bay, Espiritu Santo (CNHM 109365).

Genus *PSEUDOSSESARA*, new genus

Shell depressed, body whorl angulated, whorls about four, flattened above with spire only moderately elevated. Umbilicus open but minute. Apical whorls with extremely delicate radial riblets. Post apical whorls with very fine numerous radial riblets between moderately high, lamellate radial ribs that terminate slightly below

the periphery. Major ribs 40 on last whorl. Base of shell smooth, shining with faint subperiostracal radial lines. Colour light buff. Normal condition of lip unknown.

Animal aulacopod with well defined pedal grooves and a tripartite sole. Mantle lappets, caudal areas, apical portions not observed. Radula with tricuspid central tooth, bicuspid laterals and multicuspid marginals with long basal plates. Epiphallus with distinct lime sac, penial retractor inserted near mid-point of epiphallus, penis sheath absent. Penial cavity (Text-fig. 13) with central sac-like penis flanked by two large stimulatory pads. Spermatoaphore unknown.

Type species.—*Pseudosesara tabwemasanana*, new species

The single known specimen of *Pseudosesara* had been preserved in an acidic solution at one time, so that calcareous portions of the shell were either dissolved or seriously weakened. Lip and basal portion of the body whorl were missing upon receipt of the collection for study, and the rest of the shell cracked in several places. The animal had completely withdrawn into the shell before death. The slightest handling resulted in further damage to the specimen, and, after preparing detailed drawings, the last whorl was sacrificed in order to study portions of the anatomy. The shell alone could not indicate family position, yet full study of the anatomy could be made only by destroying the entire shell.

A compromise was attempted, with the first  $3\frac{1}{4}$  whorls remaining intact, and the lower portion of the animal cut off and dissected. The multicuspid radular marginals (Text-fig. 14) with long basal plates, aulacopod foot with tripartite sole, sigmurethrous kidney (Text-fig. 11), epiphallic lime sac and lack of additional accessory amatorial organs, place *Pseudosesara* as a member of the helicarionid subfamily *Sesarinae*.

The shell differs from the other Pacific Island sesarine genera (*Orpiella* and *Dendrotrochus*) by its depressed form with angulated periphery, strong radial ribbing above and minutely open umbilicus. In these characters it superficially resembles the Burmese-Indian genus *Sesara*, hence the generic name *Pseudosesara* for the New Hebridean species. *Sesara* differs in having an often lamellate aperture and in numerous anatomical details, but there is a basic conchological similarity. *Orpiella* differs in having a penis sheath, lacking a vergic papilla, and in having a smooth shell with a closed umbilicus. *Dendrotrochus* differs in having the penial retractor inserted at the junction of the penis and epiphallus, a quite different pilaster arrangement in the penis, and in the only superficially perforated, rib-striated, conical shell.

Probably differences will be found in the structures of the more apical genitalia, but only terminal portions (Text-fig. 12) could be examined in the present study.

*Pseudosesara tabwemasanana*, new species

(Text-figs. 11–14, Pl. I, figs. 4–6)

*Diagnosis.* A depressed helicoid shell with  $4\frac{1}{8}$  flattened whorls, an angulated periphery, radial ribs that are relatively widely spaced and terminate just below the periphery, with a smooth, shining base. Umbilicus minute, contained 18 times in the diameter. Animal a typical sesarine helicarionid with the penial retractor inserting

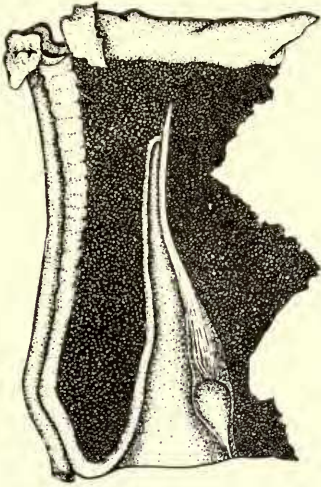


FIG. 11. *Pseudosesara tabwemasanana*. Pallial region.

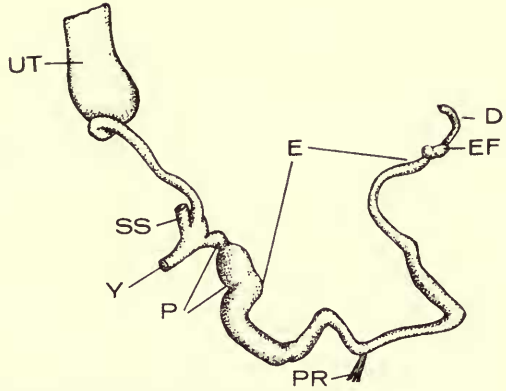


FIG. 12. *Pseudosesara tabwemasanana*. Genitalia.  
EF—epiphallic flagellum

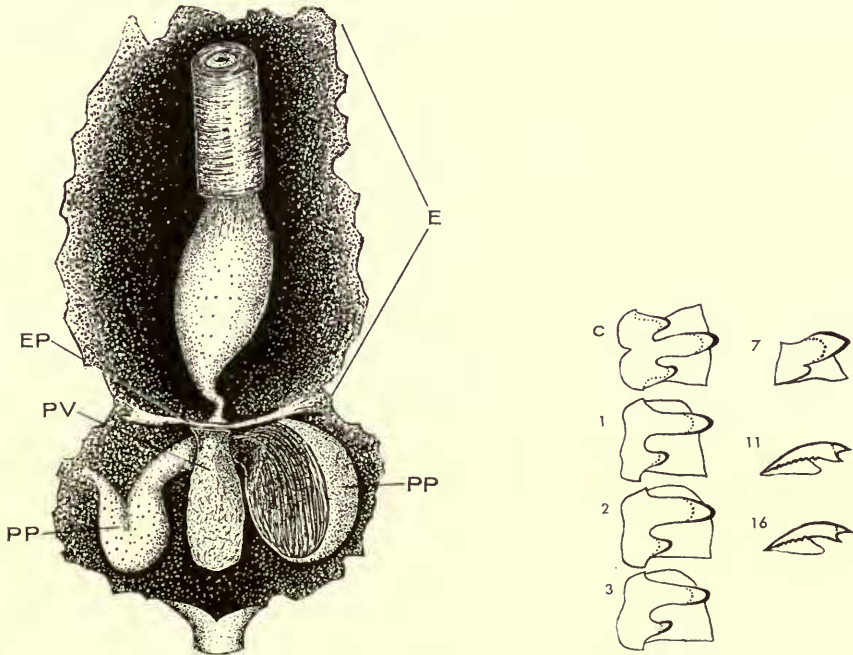


FIG. 13. *Pseudosesara tabwemasanana*. Interior of penis.

PV—penial verge  
PP—penial papilla

FIG. 14. *Pseudosesara tabwemasanana*. Radula.



near the mid-point of the epiphallus and the small, globose penial cavity containing a finger-shaped sac-like penis flanked by two large stimulatory pads.

*Holotype.* British Museum (Natural History) No. 1961655 from Tatarii Village, 4,000 feet elevation, Western Espiritu Santo, New Hebrides. Collected by John R. Baker and party in October and November 1933.

*Description.* Shell depressed helicoid with  $4\frac{1}{2}$  relatively flattened whorls. Body whorl angulated but not keeled. Apical whorls  $1\frac{5}{8}$ , very minutely radially ribbed. Remaining whorls with rather widely spaced (40 on body whorl), lamellate radial ribs that just cross the periphery, and a microsculpture of very fine radial threads between the major ribs. Base of shell smooth and shining with faint subperiostracal radial lines visible under magnification. Umbilicus open, contained 18 times in the diameter. Colour light buff with the tops of the ribs whitish. Lip broken and normal adult condition unknown. Diameter of holotype 10.82 mm., height 5.40 mm.

Animal with typical aulacopod grooves, tripartite sole with central portion narrower than the lateral areas. Pallial region (Text-fig. 11) sigmurethrous with quite elongated narrow kidney and closed secondary ureter. Terminal genitalia (Text-fig. 12) sesarine with distinct lime sac (*EF*) at terminus of epiphallus (*E*), penial retractor (*PR*) inserting slightly below mid-point of epiphallus, penis proper (*P*) small and globose, atrial opening (*Y*), spermathecal stalk (*SS*) and basal portion of uterus (*UT*) only other portions extracted. Internal structure of penis and lower epiphallic portion (Text-fig. 13) with a diaphragm (*EP*) separating the chambers of epiphallus and penis. The epiphallus is a heavy muscular tube terminating in a more glandular, thin-walled sac leading to a small tubule that passes through the diaphragm into the finger-like, thin, collapsed penis. There are two stimulatory pads: a large dished hemisphere whose base is anchored to the diaphragm and whose body lies free in the cavity and a smaller, U-shaped pad attached to the wall of the penial cavity with the base of the "U" elevated and quite swollen. Radula with 84 rows, formula 45-7-1-7-45. Teeth (Text-fig. 14) typical of family in cusp structure, distinctive only in the comparatively wide basal plates of the central and lateral teeth.

*Remarks.* *Pseudosesara tabwemasana* cannot be mistaken for any other New Hebridean shell. The ribs terminating just below the periphery, minute umbilicus and microsculpture sufficiently characterize the species. In general appearance it could be mistaken for an endodontid, but its anatomy clearly establishes its place in the Sesarinae.

## Family ZONITIDAE

### Subfamily TROCHOMORPHINAE

#### Genus *TROCHOMORPHA* Albers, 1850

#### *Trochomorpha (Hartmanitrochus) rubens* (Hartman, 1888)

*Trochomorpha (Hartmanitrochus) rubens* Hartman: Solem: 1959: 109-113, pl. 6, figs. 1, 2, 4, pl. 24, figs. 1-11, 14.

Material examined for my earlier study suggested an ecological separation into *rubens* (ground) and *convexa* (tree) under undisturbed conditions, with hybridization occurring under plantation ecology. No further data on this hypothesis are provided

by material examined in this study, but several new locality records are added. J. R. Baker in 1929 collected specimens of form *rubens* at Mt. Touri and in East Central Espiritu Santo. In 1936 Miss L. E. Cheesman found the same form at Ounua, Malekula. Borys Malkin made collections at Luganville, Espiritu Santo (CNHM 109369) and Nasuli, Baldwin Bay, Espiritu Santo (CNHM 109368). Specimens from 500–800 feet elevation above Nasaua, Maewo, New Hebrides (CNHM 109370) add a new island record. Fewer specimens were obtained of form *convexa*: some from Luganville, Espiritu Santo (CNHM 109372) and a set from 1,500–2,000 feet elevation at Bankaharijitoa above Dunduy, Aoba (CNHM 109373). The latter are a new island record and in shape correspond most closely to those figured by Solem (1959: pl. 24, fig. 8).

***Trochomorpha (Hartmanitrochus) bakeri* Solem, 1959**

*Trochomorpha (Hartmanitrochus) bakeri* Solem, 1959: 113–114, pl. 24, figs. 13, 15–17.

A single specimen from the edge of Steaming Hill Lake, Gaua, Banks Group collected in 1933 by T. Harrison is tentatively referred here. It is 15.3 mm. in diameter, 7.6 mm. high with  $5\frac{1}{8}$  whorls. The spiral colour band is wider and nearer the suture than in most specimens of *bakeri*, but it is nearer to *bakeri* than to *rubens* in colour. Preservation in formalin had eroded the surface sculpture. In some respects the Gaua shell is intermediate between *bakeri* and the Quoy and Gaimard Vanikoro specimen figured in Solem (1959: pl. 12, figs. 3–5).

Suborder HOLOPODA

Superfamily ACHATINACEA

Family SUBULINIDAE

Genus ***SUBULINA*** Beck, 1837

***Subulina octona*** (Bruguière, 1792)

*Subulina octona* (Bruguière): Solem, 1959: 118.

Records of this widely introduced snail are: near Luganville, Espiritu Santo; Vila and Devil's Point, Vate; Tenmaru and the trail from Karo to Amok at 1,000 feet, elevation Malekula; and Vureas and trail from Sola to Mosina, Vanua Lava, Banks Group (all Borys Malkin collections).

Genus ***OPEAS*** Albers, 1850

***Opeas pumilum*** (Pfeiffer, 1840)

*Opeas pumilum* (Pfeiffer): Solem, 1959: 118–119.

J. R. Baker's material included examples from Vate and Gaua, Bank's Group. Borys Malkin found it at Vila and Devil's Point, Vate; Luganville, Espiritu Santo; Norovorovo, Maewo; and the trail from Karo to Amok, Malekula. At the two localities on Vate and on Espiritu Santo it was collected with *Subulina octona*; at Norovorovo, Maewo with *Lamellaxis gracilis*.

Genus **LAMELLAXIS** Strebel and Pfeffer, 1882

**Lamellaxis** (*Allopeas*) **gracilis** (Hutton, 1834)

*Lamellaxis* (*Allopeas*) *gracilis* (Hutton): Solem, 1959: 119.

In 1934 specimens were taken near Steaming Hill Lake, Gaua, Bank's Group by T. Harrison. Borys Malkin collected a good series near Norovorovo, Maewo.

#### Family EULOTIDAE

Following an earlier usage of Pilsbry, Solem (1959) adopted the name Bradybaeniidae for this taxon. H. B. Baker (1959) indicated that it should probably be called Eulotidae and his suggestion is followed here.

Genus **BRADYBAENA** Beck, 1837

**Bradybaena** **similaris** (Ferussac, 1821)

Shells collected on Vate by J. R. Baker and near Luganville, Espiritu Santo, only confirm earlier records of this introduced species.

#### Superfamily BULIMULACEA

##### Family BULIMULIDAE

##### Subfamily BULIMULINAE

Genus **PLACOSTYLUS** Beck, 1837

**Placostylus** (*Poecilocharis*) **bicolor** (Hartman, 1889)

*Placostylus* (*Poecilocharis*) *bicolor* (Hartman): Solem, 1959: 136-137, pl. 12, figs. 6-9, pl. 22.

Three shells with the soft parts preserved were collected by T. Harrison on "Espiritu Santo" without further localization. Dissection of the soft parts suggested that use of the subfamily Placostylinae should be abandoned and *Placostylus* and *Diplomorpha* are here considered to belong to the subfamily Bulimulinae. Results of the anatomical study will be published elsewhere.

Genus **DIPLOMORPHA** Ancey, 1884

**Diplomorpha** (*Diplomorpha*) **layardi** Ancey, 1884

*Diplomorpha* (*Diplomorpha*) *layardi* Ancey: Solem, 1959: 138-141, pl. 23, figs. 7-12.

Miss L. E. Cheesman in 1936 collected a few small adults at Vila, Vate. Borys Malkin found a small adult and several juvenile shells under stones at Tenmaru, Malekula and collected a good series at 1,000 feet elevation on the trail from Karo to Amok, Malekula from ground litter (CNHM 109474). The size and shape variation of the latter set is summarized in Table 1. There is virtually no difference in measurements from the Vate populations studied by Solem (1959).



***Diplomorpha (Diplomorpha) peasei* (Cox, 1871)**

*Diplomorpha (Diplomorpha) peasei* (Cox): Solem, 1959: 141-142, pl. 19, fig. 15.

Previously there was great uncertainty as to the exact locality of this species. Aoba (=Omba) and Aore were the suggested possibilities with Aore seeming the more probable of the two. Borys Malkin, however, collected a large set between 1,500-2,000 feet elevation at Bankaharijitoa above Dünduy, Aoba (CNHM 109475) providing the first definite record. Size and shape variation are summarized in Table 1. There are no significant differences from *D. delautouri* in size, shape or whorl count, *D. peasei* being characterized only by its larger umbilicus and slightly more expanded body whorl. Possibly only subspecific differentiation is involved, but until further records are known, it seems best to treat them as distinct.

***Diplomorpha (Diplomorpha) delautouri* (Hartman, 1886)**

*Diplomorpha (Diplomorpha) delautouri* (Hartman): Solem, 1959: 142-144, pl. 19, fig. 14, pl. 23, figs. 1-6.

Borys Malkin found one average sized adult near Luganville, Espiritu Santo (CNHM 109399) and two quite large specimens from Tasmalune, Espiritu Santo (CNHM 109402). The latter measure:

h	d	h/d ratio	Whorls
30.4	20.6	1.47	5
28.4	18.3	1.55	5

making them the largest known individuals of this species.

***Diplomorpha (Quiros) bernieri* (Hartman, 1890)**

*Diplomorpha (Quiros) bernieri* (Hartman): Solem, 1959: 145-147, pl. 21, figs. 7-8.

Several examples of form *ruga* were collected on "Espiritu Santo" by J. R. Baker in 1925 and preserved in alcohol. Dissection of these did not reveal any significant differences from the anatomy of the typical subgenus. Conchological features, however, suggest that *Quiros* be retained as a valid subgrouping.

Superfamily STREPTAXACEA

Family PARYPHANTIDAE

Genus *DELOS* Hutton, 1904

***Delos (Hebridelos) rapida* (Pfeiffer, 1853)**

*Delos (Hebridelos) rapida* (Pfeiffer): Solem, 1959: 153-154, pl. 11, figs. 1-3.

J. R. Baker in 1925 collected a few specimens on Vate Island.

Genus *OUAGAPIA* Crosse, 1894

***Ouagapia santoensis* Solem, 1959**

*Ouagapia santoensis* Solem, 1959: 160-161, pl. 28, figs. 6-8.

A single shell from Espiritu Santo collected by J. R. Baker is 7.0 mm. in diameter with 4½ whorls. This is the largest known specimen of this species.

*Ouagapia perryi* (Smith, 1897)

(Pl. 2, figs. 1-3)

*"Charopa" perryi* Smith : Solem, 1959 : 88-89.

Examination of a paratype from Rotuma Island (B.M. 97.11.8.55) enabled the following redescription to be drawn :

Shell small, solid, widely umbilicated, spire but slightly elevated. Whorls a little less than four, increasing rapidly in width, moderately flattened laterally, with deeply impressed sutures. Apical whorl smooth (eroded), remaining whorls with retractively curved radial ribs which become markedly sinuate on the body whorl. No trace of spiral or microsculpture between the radials. Sculpture heavy on base of shell and continued into umbilicus. Body whorl moderately deflected, aperture ovate with heavy parietal callus. Umbilicus very wide, contained 2.75 times in the diameter. Wall of umbilicus rounded, but not keeled. Diameter 3.4 mm., height 1.97 mm.

New figures are presented in order to clarify its position. In sculpture, whorl increment and shape, colour and nuclear characters, *Ouagapia perryi* is very similar to the Tongan and Samoan Islands *Ouagapia gradata* complex, but differs significantly in having heavy radial sculpture in the umbilical region, a complete lack of spiral impressed lines and a rounded (not keeled) umbilical shoulder. The New Guinea-Bismarck-Queensland group of *O. (Torresiropa) spaldingi* differs in having a wider umbilicus with keel, a peripheral keel and reduced sculpture. None of these have been adequately studied as to anatomy and the division of *Ouagapia* into smaller phyletic units is not yet possible.

In 1925 J. R. Baker collected a single shell on Gaua, Banks Islands that measured 4.12 mm. in diameter, 2.06 mm. high with  $3\frac{5}{8}$  whorls. In comparison with the Rotuma paratype the width of the whorls increases at a more rapid rate. Until careful comparisons can be made of the Gaua shell, the Mota Island, New Hebrides holotype and the Rotuma paratypes it cannot be certain that only one species is involved. For the present, however, I prefer to use the name *perryi* to cover all three populations.

## Superorder BASOMMATOPHORA

## Superfamily LYMNACACEA

## Family PLANORBIDAE

Genus *PHYSASTRA* Tapparone-Canefri, 1883*Physastra layardi* (Ancey, 1905)*Physastra layardi* (Ancey) : Solem, 1959 : 163-164.

It must be emphasized that the name *layardi* is used only for the sake of convenience, since the New Hebridean populations are conspecific with New Caledonian forms, and, possibly, Fijian and Tongan populations belong to the same species. Until this can be determined and the nomenclature untangled, it seems best to use a name based on New Hebridean shells for the New Hebridean population.

J. R. Baker collected specimens from Steaming Hill Lake, Gaua, Banks Group in both shallow water and dredged from 30 feet deep. Both lots were juvenile, but compared well with young shells from the Espiritu Santo populations. Borys Malkin

found dead adults and live young at Devil's Point, Vate; a dead adult in drift at Nasuli, Baldwin Bay, Espiritu Santo; and live adults in a muddy stream one mile south of Nasaua, Maewo.

Genus **GYRAULUS** Charpentier, 1837

***Gyraulus (Gyraulus) montrouzieri*** (Gassies, 1863)

*Gyraulus (Gyraulus) montrouzieri* (Gassies): Solem, 1959: 164-166, pl. 33, figs. 10-12.

Borys Malkin collected six adults and several subadults at Devil's Point, Vate. J. R. Baker found three young shells on Gaua, Banks Group, one of which is typical *montrouzieri*, while the other two seem nearer to the New Caledonian *G. rossiteri* (Crosse) but are too young for positive identification.

Subclass **PROSOBRANCHIA**

Order **ARCHAEOGASTROPODA**

Superfamily **NERITACEA**

Family **HELICINIDAE**

Genus **PLEUROPOMA** Moellendorff, 1893

***Pleuropoma albescens*** (Hartman, 1890)

*Pleuropoma albescens* (Hartman), Solem, 1959: 172-173, pl. 26, figs. 5-7, 11.

Typical specimens were collected by Borys Malkin at Baldwin Bay, near Luganville, and at Nasuli on Baldwin Bay, Espiritu Santo. J. R. Baker's collections contained many specimens from Mt. Touri and East Central Espiritu Santo. The last two collections contained a few individuals of *P. sublaevigata* mixed with the *P. albescens*, while Malkin's sets were more evenly balanced in number of individuals.

***Pleuropoma sublaevigata*** (Pfeiffer, 1852)

*Pleuropoma sublaevigata* (Pfeiffer): Solem, 1959: 173-175, pl. 10, figs. 1-3, pl. 26, figs. 12, 13.

This common and widely distributed New Hebridean species was found on Gaua, Vate (Vila) and Espiritu Santo (Mt. Touri and East Central) by Baker and Cheesman. Borys Malkin collected it on Espiritu Santo (Nasuli, near Luganville, and Baldwin Bay), Aoba (Lolowai), Maewo (at 500-800 feet elevation above Nasaua, and Norovorovo School above the village), Malekula (trail from Karo to Amok at 1,000 feet elevation, and Tenmaru), and in the Banks Group on Vanua Lava (Vurass, trail from Sola to Mosina, and Mosina Bay).

The Malekula and Vanua Lava shells were relatively small, about the same size as the Espiritu Santo populations. Those from Maewo and Aoba were appreciably larger, approaching the size of *Helicina novella* Mabilie, 1895, which I had tentatively considered to be a synonym based on large individuals of *P. sublaevigata*. The types of *novella* are unknown, but the presence of populations with larger individuals of *P. sublaevigata* suggests that the proposed synonymy may be correct.

Time did not permit sexing of the numerous specimens and detailed analysis of size and shape variation.

*Pleuropoma articulata* (Pfeiffer, 1854)

*Pleuropoma articulata* (Pfeiffer) : Solem, 1959 : 176-177, pl. 10, figs. 7-9.

J. R. Baker collected specimens from Vate and Gaua. The largest specimen from Vate was 6.08 mm. in diameter, 4 mm. high with  $4\frac{3}{4}$  whorls, which greatly exceeded the size of the largest previously reported shell of this species (see Solem, 1959 : p. 171, Table XII). Borys Malkin collected several individuals at Tenmaru, Malekula (CNHM 109455).

Genus *CERATOPOMA* Moellendorff, 1893

*Ceratopoma draytonensis* (Pfeiffer, 1857)

*Helicina draytonensis* Pfeiffer, 1857, *Proc. Zool. Soc. London*, 1856 : 392—Drayton Range, North Australia ; Sowerby, 1866, *Thes. Conch.*, 3 : 286, pl. 271, figs. 199-200 ; Cox, 1868, *Monog. Austr. Land Shells*, p. 106, pl. 17, fig. 13.

*Helicina diversicolor* Cox, 1866, *Proc. Zool. Soc. London*, 1866 : 375—Pine Mt., Ipswich, Queensland ; Cox, 1868, *Monog. Austr. Land Shells*, pp. 105-106, pl. 17, fig. 9.

*Palaeohelicina (Ceratopoma) diversicolor* (Cox) : Wagner, 1911, *Syst. Conch. Cab.*, I, 18, (2), p. 262, pl. 52, figs. 5-7 (very poor).

*Ceratopoma draytonensis* (Pfeiffer) : Iredale, 1937, *Austr. Zool.*, 8, (4), p. 293.

Two specimens collected by Borys Malkin at 500-800 feet elevation above Nasaua, Maewo (CNHM 109458) are totally different from any previously known New Hebridean helicimid. Their smooth, shining surface, callus and configuration of the umbilical lip are the same type found in the Australian *Ceratopoma*. Comparison with available material showed that it was nearly identical with a Port Curtis, Queensland specimen (CNHM 28556) that was labelled *C. gladstonensis* (Cox), but agrees closely with the type figures of *draytonensis*.

The synonymy cited above is taken from the literature, since I did not have sufficient material to enable study of the limits of variation in the Australian species of *Ceratopoma*. The specific designation is uncertain, but I have no hesitation in considering that the New Hebridean shell is an Australian *Ceratopoma* that has been accidentally introduced into the New Hebrides, probably on plants. Other possible New Hebridean-Australian imports are discussed by Solem (1959), so that this does not seem to be an isolated case.

## Order MESOGASTROPODA

## Suborder ARCHITAENIOGLOSSA

## Superfamily CYCLOPHORACEA

## Family POTERIIDAE

Solem (1959) discussed the probable relationships of *Ostodes*, *Gonatoraphe* and *Gassiesia*. The male and female organs of the first two genera were briefly discussed, but no data was available on *Gassiesia*. Borys Malkin collected a single small male of *Gassiesia couderti* (Fischer & Bernardi) from Kuto, Ile des Pins, New Caledonia (CNHM 109427). The mid-dorsal verge has a closed seminal groove and a very long terminal appendage, about twice the length of that found in the New Hebridean *Gonatoraphe fornicata*. *Gassiesia* thus is nearer to *Gonatoraphe* in vergic structure than to the Samoan *Ostodes*.



Genus *GONATORAPHE* Moellendorff, 1898*Gonatoraphe fornicata* (Pfeiffer, 1854)

*Gonatoraphe fornicata* (Pfeiffer) : Solem, 1959 : 183-185, pl. 6, figs. 9-10, pl. 9, figs. 4-6, pl. 26, figs. 1-2.

J. R. Baker in 1925 found very small juvenile shells on Vate. Borys Malkin collected large adults at Tasmalune, Espiritu Santo (CNHM 109424) ; juvenile shells at Tenmaru, Malekula (CNHM 109426) and at 500-800 feet elevation above Nasaua, Maewo (CNHM 109425) ; and relatively small adults at 1,000-1,500 feet elevation at Bankaharijitoa above Dunduy, Aoba (CNHM 109423).

## Family PUPINIDAE

## Subfamily PUPININAE

Genus *PUPINA* Vignard, 1829

Solem (1959, pp. 186-189) briefly discussed the classification of the Pupininae and suggested that most of the genera proposed by Clench (1949) be reduced to sectional or subgeneric ranking. In the Solomons and New Hebrides, Clench (loc. cit.) recognized two genera, distinguished by the presence (*Pupina*) or absence (*Kanapa*) of an apertural notch. Solem (1959, p. 189) recorded variation in *Pupina* (*Kanapa*) *cumingiana* (Pfeiffer) from Tanna Island, New Hebrides that ranged from a notched form to one with no notch, thus forming a transition between *Pupina* and *Kanapa*. The latter name was retained as a convenient sectional name for all the known New Hebridean and the notchless Solomon Island species. The discovery of a notched New Hebridean *Pupina*, described below, raises doubts as to even the sectional utility of *Kanapa*. Just as in the Palau and Caroline Islands there is a series of species showing progressive reduction in the prominence of the apertural notch, so in the New Hebrides there is a transition from the notched new species to the sometimes notched *cumingiana* and notchless *brazieri*. Pending anatomical studies of the species, *Kanapa* has been retained as a convenient term for notchless species, but it certainly is not of generic or subgeneric importance.

*Pupina* (*Kanapa*) *brazieri* (Crosse, 1870)

*Pupina* (*Kanapa*) *brazieri* (Crosse) : Solem, 1959 : 188.

*Remarks.* A number of specimens were collected near Luganville, Espiritu Santo by Borys Malkin (CNHM 109428). The shells were relatively larger than those collected by Kuntz (see Solem, loc. cit.) and variation in the largest sample is summarized in Table I. None of the shells showed any sign of an apertural notch.

*Pupina* (*Kanapa*) *cumingiana* (Pfeiffer, 1853)

*Pupina* (*Kanapa*) *cumingiana* (Pfeiffer) : Solem, 1959 : 189, pl. 9, fig. 8.

A single adult shell collected by J. R. Baker on Vate is 7.0 mm. high, 3.2 mm. in diameter and has a slight trace of an apertural notch.



*Pupina (Pupina) malkini* new species

Text-fig. 15

*Diagnosis.* A species of *Pupina* paralleling the Caroline Island *Pupina brenchleyi* E. A. Smith in the degree of reduction of the apertural notch, but distinguished from all Melanesian and Micronesian species by its skewed apex, shouldered antepenultimate whorl and extremely long penultimate whorl.

*Holotype.* Chicago Natural History Museum No. 109417, collected at 500–800 feet elevation, above Nasaua, Maewo, New Hebrides by Borys Malkin on 4th September, 1958.

*Description.* Shell solid, shining, with an orange tint to the basically yellow-horn colouration, surface sculpture absent. Whorls five, sutures of first three slightly indented and whorls a little bit convex. Antepenultimate whorl distinctly shouldered in front at a point well below the middle of the whorl, rounded behind. Penultimate whorl flattened in front, quite elongated, suture not indented and descending

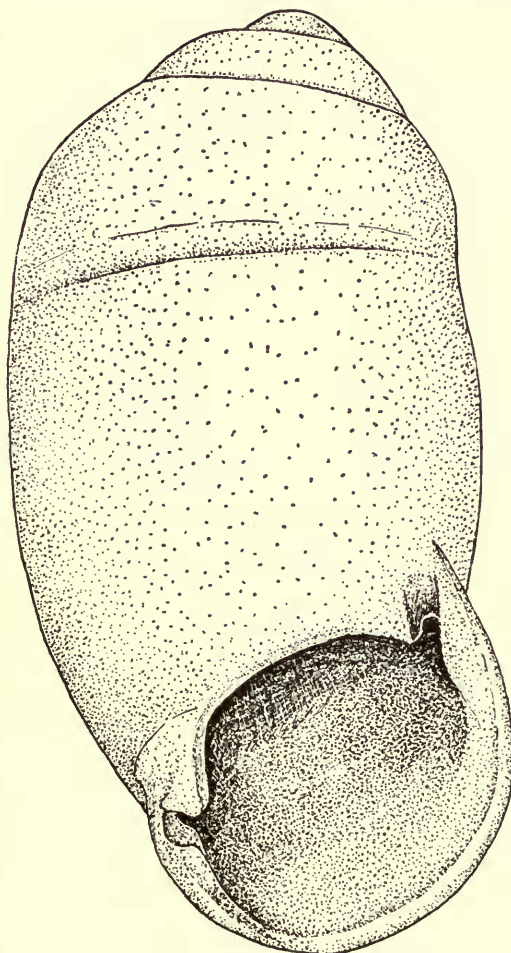


FIG. 15. *Pupina malkini*, new species. Holotype.



rapidly behind. Apex and upper spire usually distinctly tilted to the right. Aperture circular in adults, subovate in juveniles, with a strong diagonal columellar notch (exceptionally widely open in the holotype) and apertural notch composed of a small parietal tooth and a prominent palatal groove that is slightly obscured by a thickening of the lip. Operculum thin, horny, slightly concave multispiral with a central nucleus. Holotype 5.1 mm. high, diameter 2.56 mm., whorls 5.

*Paratypes.* Chicago Natural History Museum No. 109418, Bernice P. Bishop Museum No. 215240, British Museum (Natural History) No. 1961656 from the type locality.

*Range.* Vanua Lava, Banks Islands and Maewo, New Hebrides.

*Remarks.* Size and shape variation are summarized in Table I. Most of the type set corresponds closely to the holotype in form, although some individuals have the apex much less sharply tilted and the penultimate whorl slightly shorter. There is great variation in the shape and degree of openness of the columellar notch. The figured holotype is unusually widely open while most paratypes have a notch that corresponds closely to that of *Pupina keradreni* Vignard (see Clench, 1949: p. 32, fig. 18-c). In three juvenile shells the notch is shallow, nearly vertical and much as in the figures of *Pupinoa* (see Clench, 1949, p. 37, fig. 21), becoming horizontal and partially closed in adults through thickening of the lip. This raises the possibility that the few specimens described as species of *Pupinoa* may be juveniles of species of *Pupina*. The apertural notch is reduced in comparison to that of the Solomon Island *P. keradreni*, but equivalent to the notch of *P. brenchleyi* from the Caroline Islands. In juvenile shells the notch is reduced to the extent found in the Caroline Island *P. complanata* Pease.

On Vanua Lava, Banks Island, Borys Malkin collected one live adult on the trail from Sola to Mosina (CNHM 109419) and four live adults at Vureas (CNHM 109422). In size, shape and apertural characters they fall within the range of variation shown by the type set and no hesitation is felt in referring them to this species.

*Pupina brazieri* is larger, never has any sign of an apertural notch, lacks the shouldering of the antepenultimate whorl and has a shorter penultimate whorl.

#### Superfamily RISSOACEA

#### Family HYDROBIIDAE

#### Genus *FLUVIOPUPA* Pilsbry, 1911

#### *Fluviopupa brevior* (Ancey, 1905)

*Fluviopupa brevior* (Ancey) : Solem, 1959 : 195-196, pl. 6, fig. 11, pl. 27, figs. 5, 6.

The specimens reported by Baker (1929) from Steaming Hill Lake, Gaua as *Potamopyrgus* sp. were examined and unquestionably are a *Fluviopupa*. Preservation in formalin had seriously weakened and decoloured the shells so that handling was difficult. They are a little more slender and elongated than the Espiritu Santo shells studied previously, but were too delicate to allow the handling needed for accurate measurements or dissection. Possibly the Gaua shells are subspecifically or specifically distinct, but until the extent of interpopulational variation can be determined, taxonomic recognition is not warranted.

## Family ASSIMINEIDAE

Genus *OMPHALOTROPIS* Pfeiffer, 1851

Without considerable anatomical studies it will be impossible to adequately classify the species assigned to this genus. Numerous subgeneric and sectional names recognize conchological variations, but none of these names can be considered to recognize phyletic units. A case in point is the meaning of *Stenotropis* and *Oriella*. The former covers elongate, yellowish brown shells with an umbilical keel and no prominent surface sculpture; the latter species with similar umbilicus and sculpture, but with deeply indented sutures and fewer whorls. Both types are found in the Marianas, Fijis and New Hebrides, and probably the varying forms in each area are more closely related to each other than to their counterpart in the further island groups. The two names are convenient terms to indicate a type of shell structure, but may not represent phylogeny. The endemic New Hebridean group, *Lyrotropis*, is of uncertain affinity to extra-limital forms.

*Omphalotropis (Lyrotropis) conella* Sykes, 1903

*Omphalotropis (Lyrotropis) conella* Sykes: Solem, 1959: 203, pl. 11, fig. 5.

J. R. Baker found a few juvenile shells on Vate and Borys Malkin collected four nearly adult shells at 500–800 feet above Nasaua, Maewo (CNHM 109403).

*Omphalotropis (Lyrotropis) poecila* Ancey, 1890

*Omphalotropis (Lyrotropis) poecila* Ancey: Solem, 1959: 202–203, pl. 6, figs. 12, 13, pl. 26, figs. 9, 10.

J. R. Baker's collections included specimens from Mt. Touri, Hog Harbour, and East Central Espiritu Santo plus a few from Vate. Borys Malkin found a good set near Luganville and one adult at Nasuli, Baldwin Bay, Espiritu Santo, and a series at 1,500–2,000 feet elevation at Bankaharijitoa above Dunduy, Aoba (CNHM 109367).

*Omphalotropis (Stenotropis) acrostoma* new species

Text-fig. 16

*Diagnosis.* A species perhaps most similar to the Caroline Island *Omphalotropis laevis* (Pease), but differing by its less swollen spire, larger umbilicus, thicker lip and more flaring aperture. The New Hebridean *Omphalotropis (Oriella) setocincta* Ancey is very similar in sculpture and umbilical characters, but has fewer whorls, much more deeply indented sutures and a less flaring aperture.

*Type.* Chicago Natural History Museum No. 109407, collected on the trail from Sola to Mosina, Vanua, Banks Is., New Hebrides by Borys Malkin on 9th–11th August, 1958.

*Description.* Shell relatively small, height about 5 mm., elongate conic with the spire not swollen. Surface minutely granulose, dull, without sculpture other than very faint growth lines. Colour a light yellow brown with a dull reddish subsutural

zone on the upper whorls and occasionally a reddish tint to the inside of the aperture. Whorls  $5\frac{3}{4}$ – $6\frac{1}{8}$ , sutures only slightly indented and whorls at most moderately convex, never shouldered below the suture. Umbilicus a narrow chink with a moderately conspicuous, white tinted carina. Aperture ovate, moderately flaring with thickened

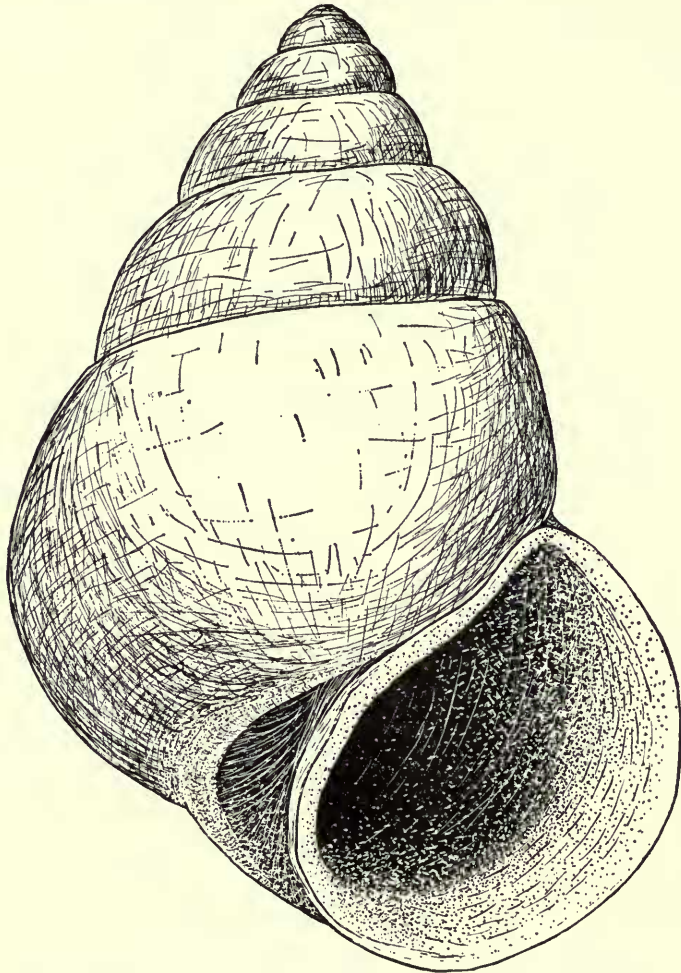


FIG. 16. *Omphalotropis acrostoma*, new species. Holotype.

columellar lip and heavy parietal callus. Basal lip slightly angulated. Operculum, thin, horny, flexible, with acentral nucleus and a few scattered calcareous granules on the surface. Animal typical of the genus with proboscis cape that is bifurcate dorsally, short stubby grey flecked tentacles, and heavily grey flecked mantle. Sexes separate, but no differences in size of male and female shells. Male with very large cephalic verge situated mid-dorsally. Tip varying from arrow- to axe-shaped. Holotype 5.25 mm. high, diameter 3.5 mm., with 6 whorls.

*Paratypes.* Chicago Natural History Museum No. 109406, Bernice P. Bishop Museum No. 215241, British Museum (Natural History) No. 1961657 from the type set.

*Remarks.* The flaring lip, less indented sutures, and one-half more whorl effectively separate *O. acrostoma* from *O. setocincta*. The combination of flaring lip, more whorls and shallower sutures gives the subjective impression that *O. acrostoma* is a much more slender shell with longer spire than is *O. setocincta*. Measurements of the two species show little difference (see Table I) except in whorl count and the apparent difference seems to be an optical illusion.

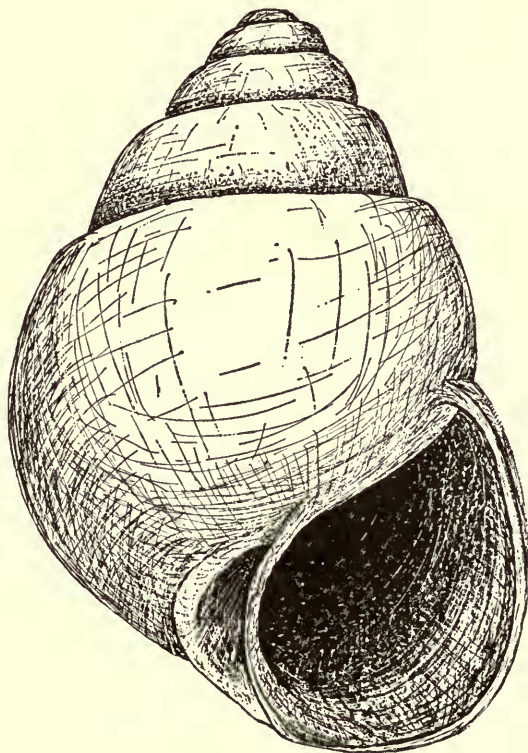


FIG. 17. *Omphalotropis setocincta* Ancy.

Measurements of ten males and ten females did not differ significantly, and, by shell alone, the sex cannot be determined. The gross external anatomy is not distinguishable from that of the Mariana *O. cookei* (Abbott, 1949, p. 265, fig. 1) except for the larger tip on the verge and slightly shorter tentacles. No comprehensive study on the anatomy of *Omphalotropis* has been published. Well preserved examples of the soft parts were available, but time did not permit a study of the internal anatomy.

Besides the type set, four adult males and two females were collected by Borys Malkin at Vureas, Vanua Lava (CNHM 109408).



*Omphalotropis (Oriella) setocincta* Ancey, 1890

Text-fig. 17

*Omphalotropis (Oriella) setocincta* Ancey : Solem, 1959 : 200-201, pl. 27, figs. 8, 9.

*Remarks.* Two dwarf (4.06-4.12 mm. high) adults were collected by Borys Malkin at Norovorovo, Maewo (CNHM 109409). One of these is figured for comparison with the new species described above. J. R. Baker found a few on Vate and four adults on Gaua in 1925. The latter were 3.56-4.37 mm. high, diameter 2.56-2.69, h/d ratio 1.39-1.67 with  $5\frac{1}{2}$ - $5\frac{5}{8}$  whorls, thus being slightly smaller than Espiritu Santo examples.

## C. LIST OF NEW ISLAND RECORDS

The following lists are supplemental to Appendix II in Solem (1959). Only new records or confirmation through specimen examination of listings based on literature records are included. Much of the material reported on above duplicated island records listed in Solem (1959) so that nothing would be gained by presenting a list of all island records mentioned earlier.

## VATE

*Pupina cumingiana* (Pfeiffer)

## MALEKULA

<i>Partula pyramis</i> Hartman	<i>Opeas pumilum</i> (Pfeiffer)
<i>Phrixgnathus glissoni</i> (Ancey)	<i>Diplomorpha layardi</i> Ancey
<i>Orpiella retardata depressa</i> Solem	<i>Pleuropoma sublaevigata</i> (Pfeiffer)
<i>Dendrotrochus eva eva</i> (Pfeiffer)	<i>Pleuropoma articulata</i> (Pfeiffer)
<i>Subulina octona</i> (Bruguière)	<i>Gonatoraphe fornicata</i> (Pfeiffer)

## AOBA (=OMBA)

<i>Coneuplecta microconus</i> (Mousson)	<i>Pleuropoma sublaevigata</i> (Pfeiffer)
<i>Dendrotrochus eva eva</i> (Pfeiffer)	<i>Gonatoraphe fornicata</i> (Pfeiffer)
<i>Trochomorpha rubens convexa</i> Hartman	<i>Omphalotropis poecila</i> Ancey
<i>Diplomorpha peasei</i> (Cox)	

## MAEWO

<i>Gastrocopta pediculus</i> (Shuttleworth)	<i>Physastra layardi</i> (Ancey)
<i>Mocella euryomphala</i> Solem	<i>Pleuropoma sublaevigata</i> (Pfeiffer)
<i>Liardetia samoensis</i> (Mousson)	<i>Ceratopoma draytonensis</i> (Pfeiffer)
<i>Dendrotrochus eva eva</i> (Pfeiffer)	<i>Gonatoraphe fornicata</i> (Pfeiffer)
<i>Trochomorpha rubens rubens</i> Hartman	<i>Pupina malkini</i> Solem
<i>Opeas pumilum</i> (Pfeiffer)	<i>Omphalotropis conella</i> Sykes
<i>Lamellaxis gracilis</i> (Hutton)	<i>Omphalotropis setocincta</i> Ancey

## ESPIRITU SANTO

*Phrixgnathus tatariensis* Solem*Pseudosesara tabwemasanana* Solem

## GAUA

*Succinea kuntziana* Solem*Physastra layardi* (Ancey)*Mocella euryomphala* Solem*Gyraulus montrouzieri* (Gassies)*Coneuplecta microconus* (Mousson)*Pleuropoma sublaevigata* (Pfeiffer)*Trochomorpha bakeri* Solem*Pleuropoma articulata* (Pfeiffer)*Lamellaxis gracilis* (Hutton)*Fluviopupa brevior* (Ancey)*Ouagapia perryi* (Smith)*Omphalotropis setocincta* Ancey

## VANUA LAVA

*Partula auraniiana* Hartman*Pleuropoma sublaevigata* (Pfeiffer)*Liardetia samoensis* (Mousson)*Pupina malkini* Solem*Dendrotrochus eva stramineus* Sykes*Omphalotropis acrostoma* Solem*Subulina octona* (Bruguière)

## D. ZOOGEOGRAPHIC COMMENTS

Of the 53 island records listed in section C, seven represent confirmation of early literature records and the remaining forty-six are based on data accumulated during this study. Particularly important are the records from Malekula, Maewo, Omba and Gaua, islands from which none or only a very few non-marine molluscs have been reported. Our knowledge of the fauna is still quite inadequate, since no non-marine molluscs are known from the large islands of Ambrym and Pentecost and very few from the Torres and Santa Cruz groups. Fifty species are now known from Espiritu Santo, 28 from Vate, 21 from Aneiteum (excluding dubious records), 15 from Maewo, and 12 from Tanna, Gaua and Malekula. Undoubtedly these are only partial enumerations of the existing faunas.

Despite our fragmentary knowledge, the data presented above do allow a few general comments about distribution patterns within the New Hebrides. This is in direct contrast with Solem (1959) where the lack of island records forced concentration of effort on generic and family distributions in other island groups. First, there are a number of land snail species that are endemic to the New Hebrides, yet are widely distributed within the island chain without apparent systematically important variations. *Pleuropoma sublaevigata*, reported from twelve islands, is the most widespread endemic, with *Trochomorpha rubens* and *Gonatoraphe fornicata* known from seven islands each, *Dendrotrochus eva eva* and *Succinea kuntziana* from five, *Omphalotropis poecila* probably from four, and *Mocella euryomphala*, *Phrixgnathus glissoni*, and *Omphalotropis conella* from three islands. Both the list of species and the number of island records will undoubtedly be increased by further collecting. These data suggest that there has been probably relatively free faunal interchange between at least certain islands in the not too distant past, or less probably, that the snail

fauna is well enough balanced that specific radiation has been comparatively minor in geologically recent times. Regardless of the reason for the wide distribution, the lack of uni-insular endemism is in striking contrast to the faunas of the Marquesas or Hawaiian Islands.

Secondly, we have some data on the degree of faunal relationship between neighbouring islands. Malekula is separated from Espiritu Santo by the narrow and shallow Bougainville Strait, which almost certainly was bridged by land during Pleistocene glaciations. In contrast, Vate Island is separated from Malekula by a wide and very deep water gap. The three islands have several widely distributed endemics (*Pleuropoma sublaevigata*, *P. articulata*, *Gonatoraphe fornicata*, and *Trochomorpha rubens*) in common, and one endemic species (*Phrixgnathus glissoni*) is known only from the three islands. One species (*Phrixgnathus tenuiscriptus*) and one subspecies (*Orpiella retardata depressa*) are restricted to Malekula and Espiritu Santo. Typical *Orpiella retardata* is known from Vate and Aneiteum. Vate and Malekula have *Diplomorpha layardi* and *Dendrotrochus eva eva* in common. *Diplomorpha layardi* is restricted to the two islands and replaced on Espiritu Santo by *D. delautouri*. *Dendrotrochus eva eva* is also found on Epi, Aoba and Maewo, but replaced on Espiritu Santo by the endemic *Dendrotrochus layardi*. Thus, two Espiritu Santo endemics failed to reach nearby Malekula, while two Vate Island forms successfully colonized Malekula. In our present state of knowledge, there is as much faunal resemblance between Malekula and Vate as there is between Malekula and Espiritu Santo.

Finally, the recording of *Trochomorpha bakeri* from Gaua is another indication of the relationship between the Southern and Northern islands (Solem, 1959 : 206) with more distantly related forms in the central group.

The new species described above make no major changes in the general faunal composition of the New Hebridean land snails. Solem (1959 : 316-317) indicated that the New Hebridean endemic land snails contained about equal numbers of Palaeo-Oriental, Southern Relict and Pacific Island taxa. Of the new species recognized above, *Phrixgnathus tatariensis* is of Southern Relict affinity, *Omphalotropis acrostoma* is Pacific Island, and both *Pupina malkini* and *Pseudosesara tabwemasanana* belong to Palaeo-Oriental groups.

On the basis of information gained during this study and in reviewing the material used in Solem (1959), I would suggest that probably less than half of the New Hebridean non-marine species have been collected and studied at the present time, and that only a small fraction of the data bearing on inter-island distribution is known.



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